FIG. 1

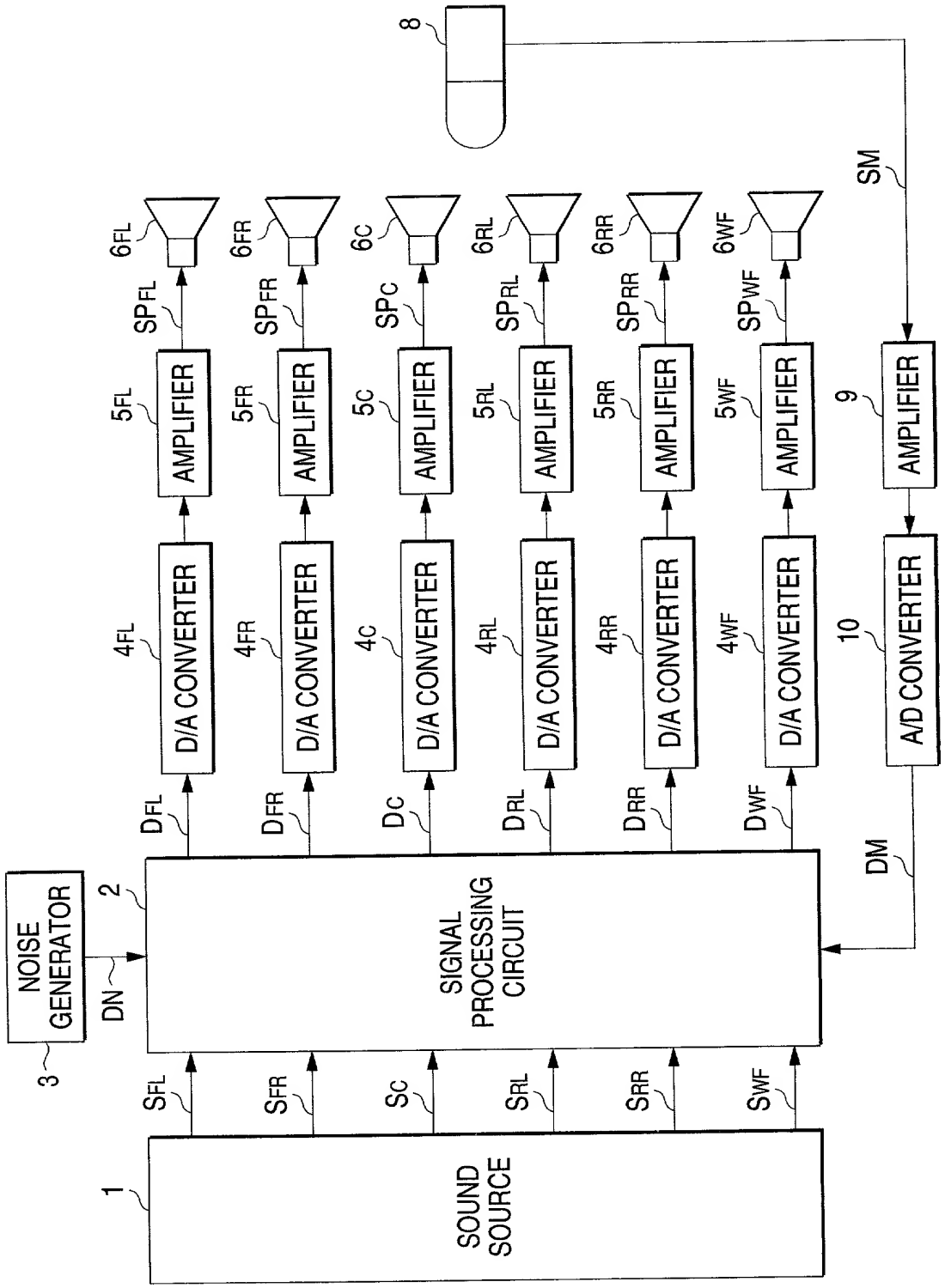
1
SOUND SOURCE
SFL
SFR
SC
SRL
SRR
SWF
3
NOISE GENERATOR
DN
2
SIGNAL PROCESSING CIRCUIT
DFL
DFR
DC
DRL
DRR
DWF
4FL
D/A CONVERTER
4FR
D/A CONVERTER
4C
D/A CONVERTER
4RL
D/A CONVERTER
4RR
D/A CONVERTER
4WF
D/A CONVERTER
5FL
AMPLIFIER
5FR
AMPLIFIER
5C
AMPLIFIER
5RL
AMPLIFIER
5RR
AMPLIFIER
5WF
AMPLIFIER
6FL
SPFL
6FR
SPFR
6C
SPC
6RL
SPRL
6RR
SPRR
6WF
SPWF
8
SM
9
AMPLIFIER
10
A/D CONVERTER
DM

FIG. 2

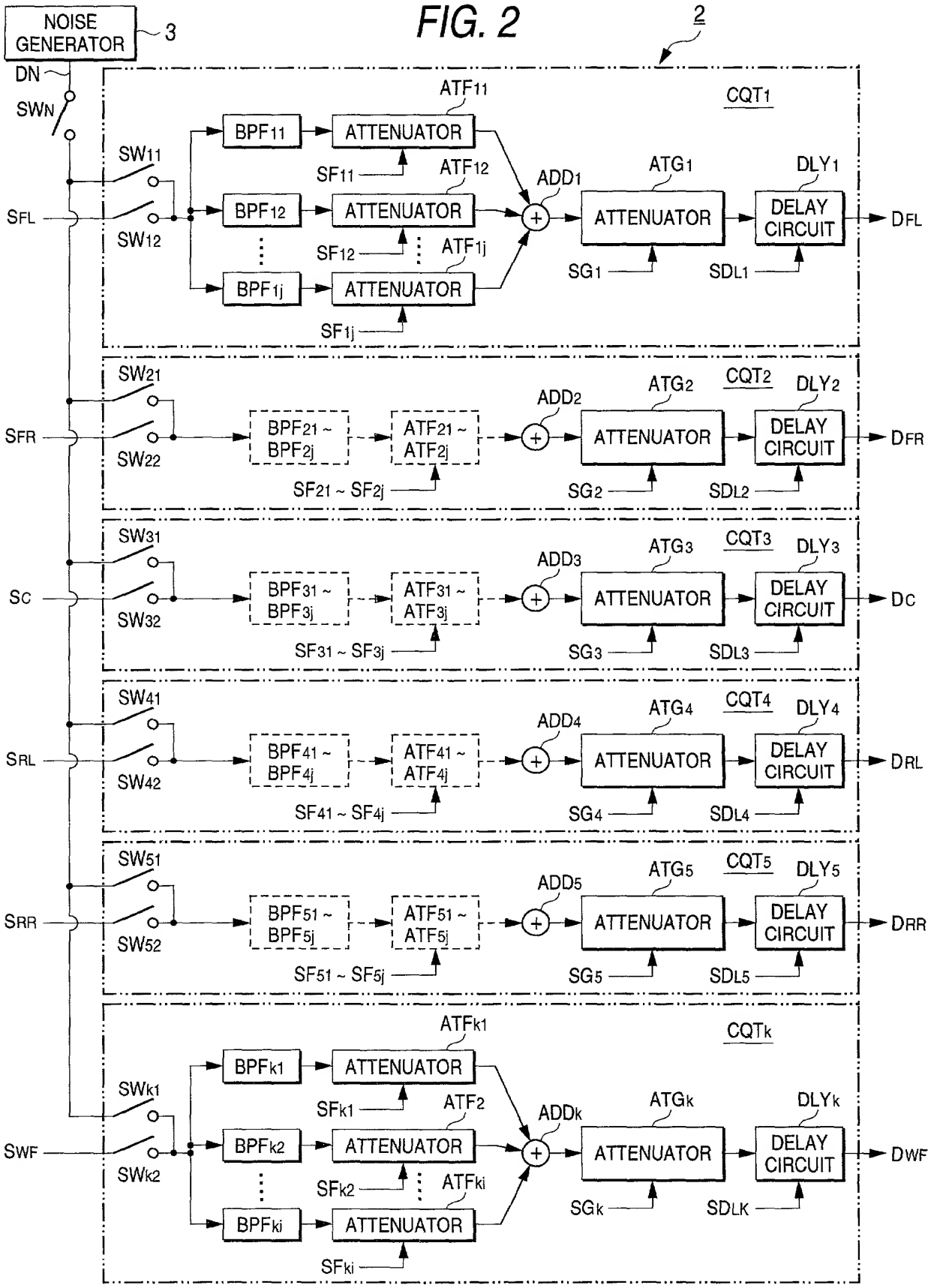
2
NOISE GENERATOR
3
DN
SWN
SFL
SFR
SC
SRL
SRR
SWF
SW11
SW12
SW21
SW22
SW31
SW32
SW41
SW42
SW51
SW52
SWk1
SWk2
BPF11
BPF12
BPF1j
BPF21 ~ BPF2j
BPF31 ~ BPF3j
BPF41 ~ BPF4j
BPF51 ~ BPF5j
BPFk1
BPFk2
BPFki
ATF11
ATF12
ATF1j
ATF21 ~ ATF2j
ATF31 ~ ATF3j
ATF41 ~ ATF4j
ATF51 ~ ATF5j
ATFk1
ATF2
ATFki
SF11
SF12
SF1j
SF21 ~ SF2j
SF31 ~ SF3j
SF41 ~ SF4j
SF51 ~ SF5j
SFk1
SFk2
SFki
ATTENUATOR
ADD1
ADD2
ADD3
ADD4
ADD5
ADDk
ATG1
ATG2
ATG3
ATG4
ATG5
ATGk
SG1
SG2
SG3
SG4
SG5
SGk
DELAY CIRCUIT
DLY1
DLY2
DLY3
DLY4
DLY5
DLYk
SDL1
SDL2
SDL3
SDL4
SDL5
SDLK
CQT1
CQT2
CQT3
CQT4
CQT5
CQTk
DFL
DFR
DC
DRL
DRR
DWF

FIG. 3

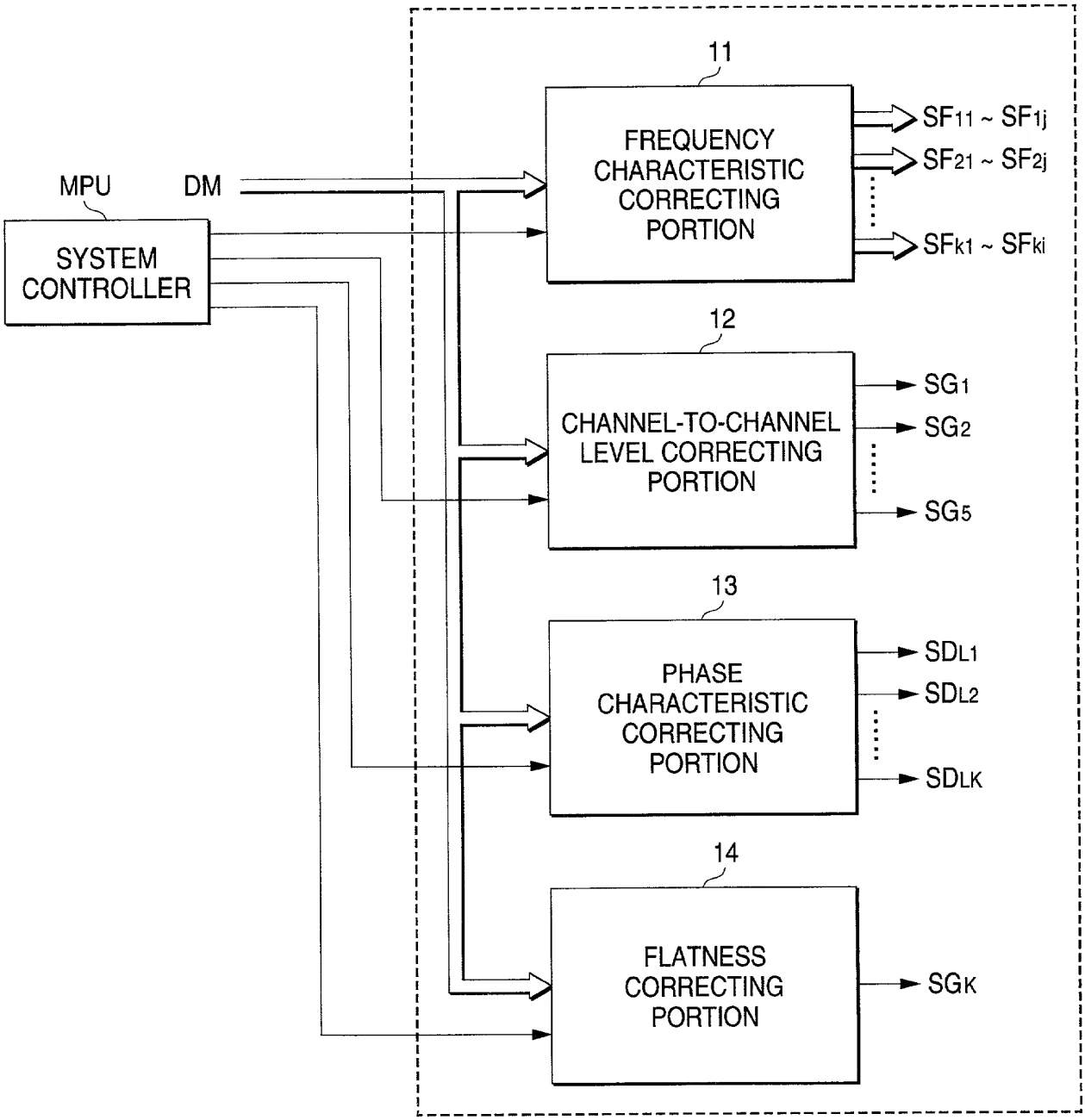
11
FREQUENCY CHARACTERISTIC CORRECTING PORTION
SF11 ~ SF1j
SF21 ~ SF2j
SFk1 ~ SFki
MPU
DM
SYSTEM CONTROLLER
12
CHANNEL-TO-CHANNEL LEVEL CORRECTING PORTION
SG1
SG2
SG5
13
PHASE CHARACTERISTIC CORRECTING PORTION
SDL1
SDL2
SDLK
14
FLATNESS CORRECTING PORTION
SGK

FIG. 4

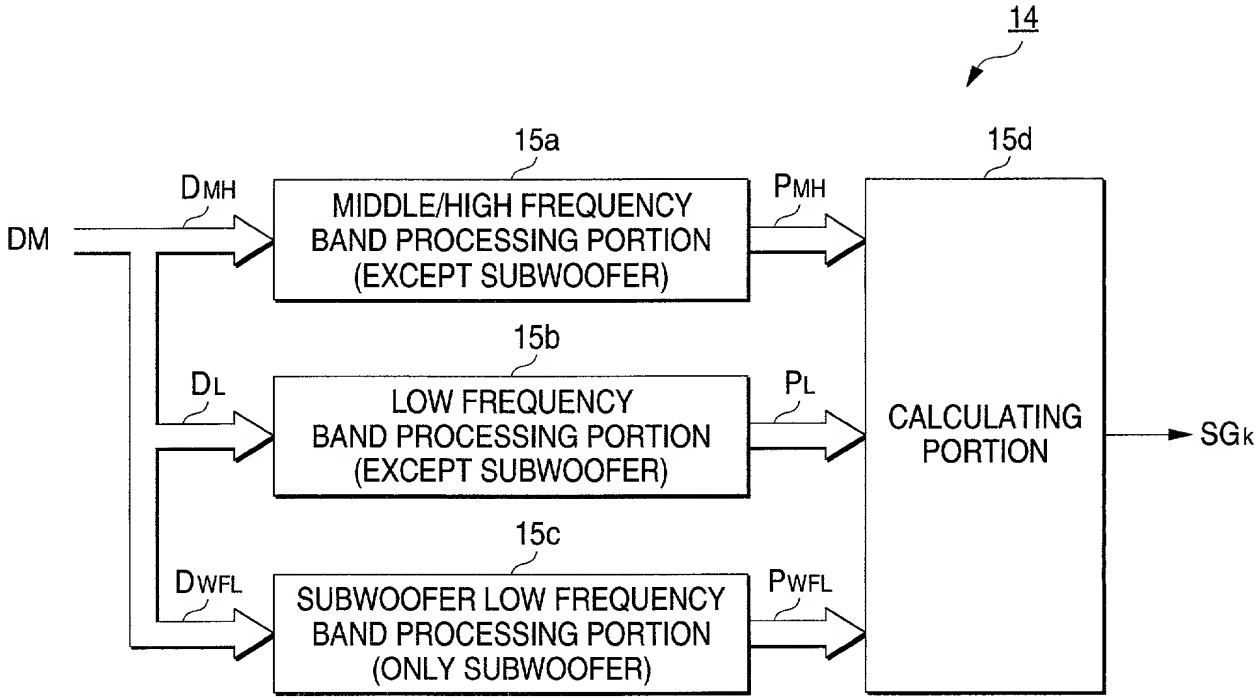
14
15a
15d
DMH
PMH
DM
MIDDLE/HIGH FREQUENCY BAND PROCESSING PORTION (EXCEPT SUBWOOFER)
15b
DL
PL
LOW FREQUENCY BAND PROCESSING PORTION (EXCEPT SUBWOOFER)
CALCULATING PORTION
SGk
15c
DWFL
PWFL
SUBWOOFER LOW FREQUENCY BAND PROCESSING PORTION (ONLY SUBWOOFER)

FIG. 5

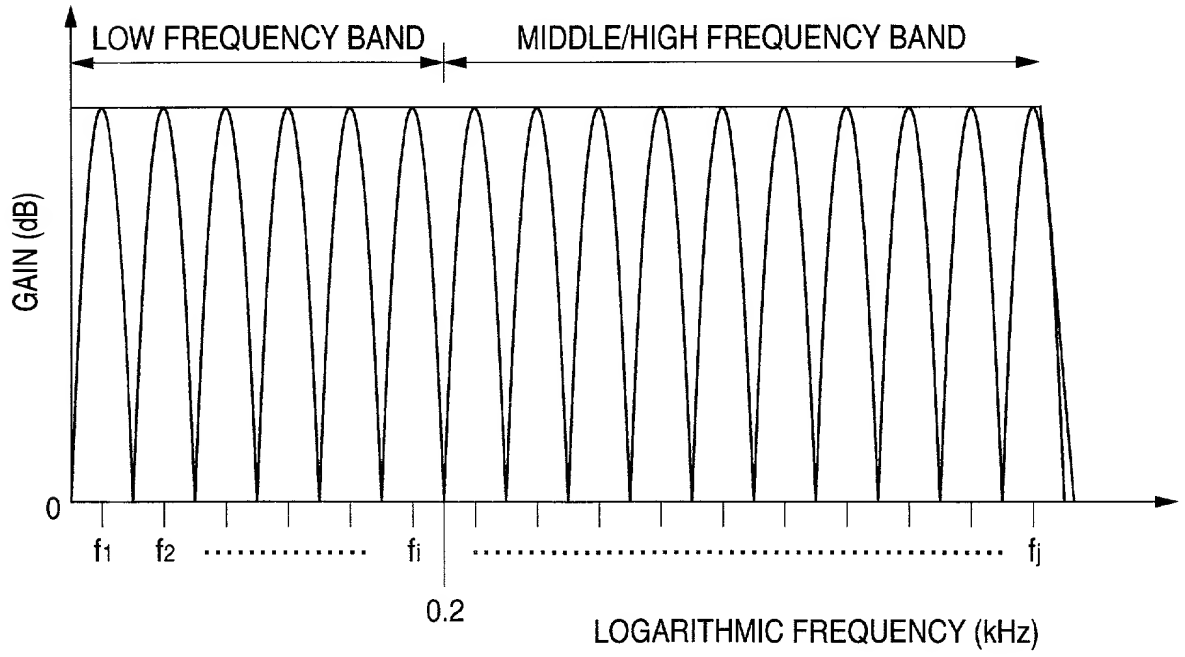
LOW FREQUENCY BAND
MIDDLE/HIGH FREQUENCY BAND
GAIN (dB)
0
f1
f2
fi
fj
0.2
LOGARITHMIC FREQUENCY (kHz)

FIG. 6

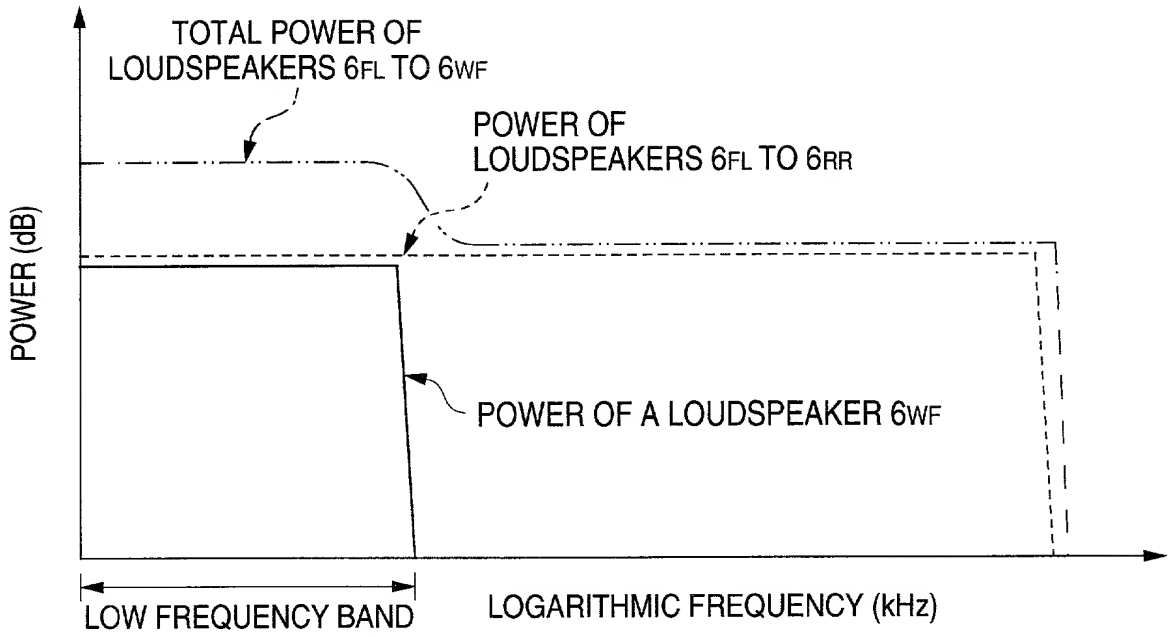
TOTAL POWER OF
LOUDSPEAKERS 6FL TO 6WF
POWER OF
LOUDSPEAKERS 6FL TO 6RR
POWER OF A LOUDSPEAKER 6WF
POWER (dB)
LOW FREQUENCY BAND
LOGARITHMIC FREQUENCY (kHz)

FIG. 7

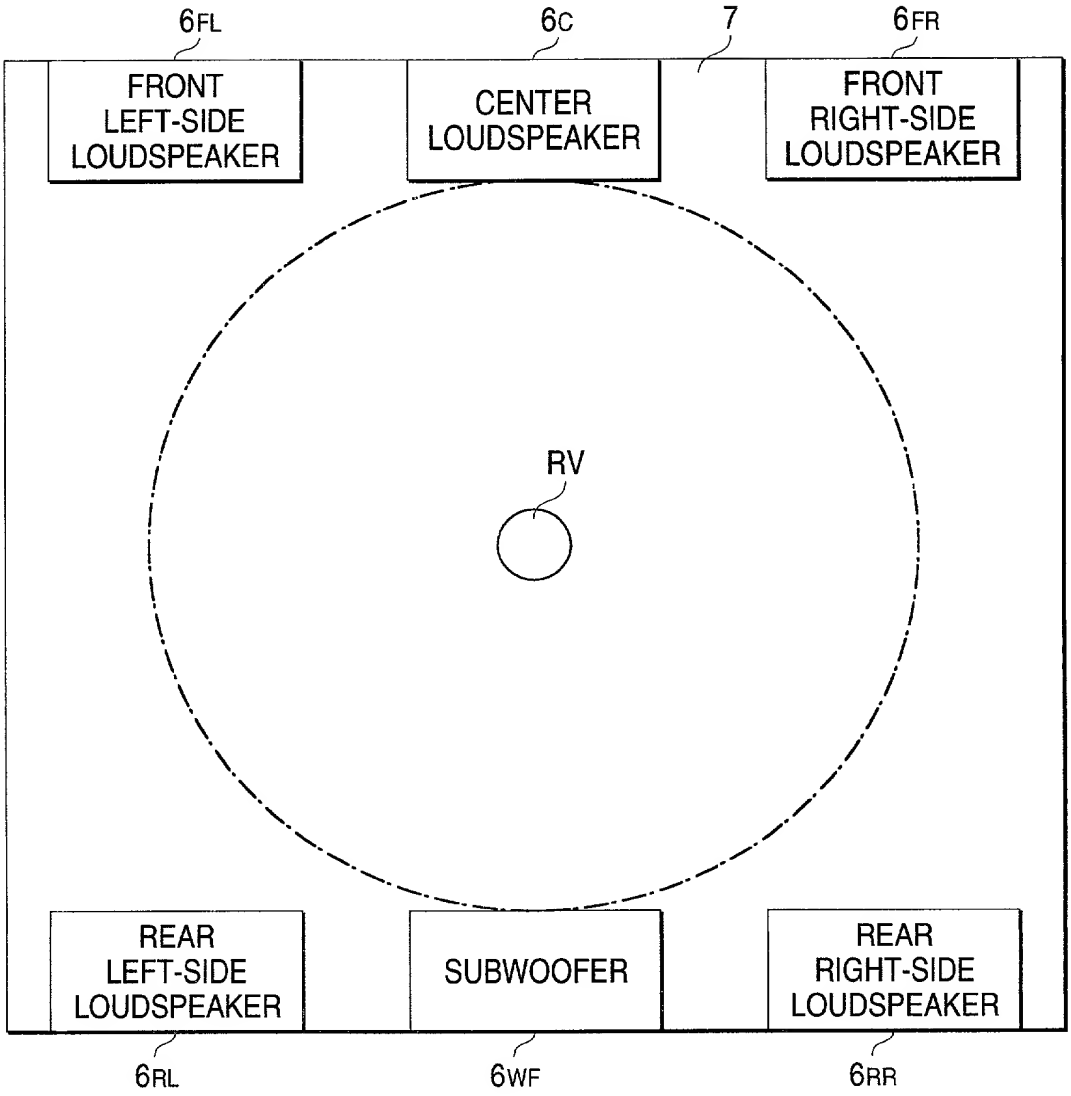
6FL
6C
7
6FR
FRONT LEFT-SIDE LOUDSPEAKER
CENTER LOUDSPEAKER
FRONT RIGHT-SIDE LOUDSPEAKER
RV
REAR LEFT-SIDE LOUDSPEAKER
SUBWOOFER
REAR RIGHT-SIDE LOUDSPEAKER
6RL
6WF
6RR

FIG. 8

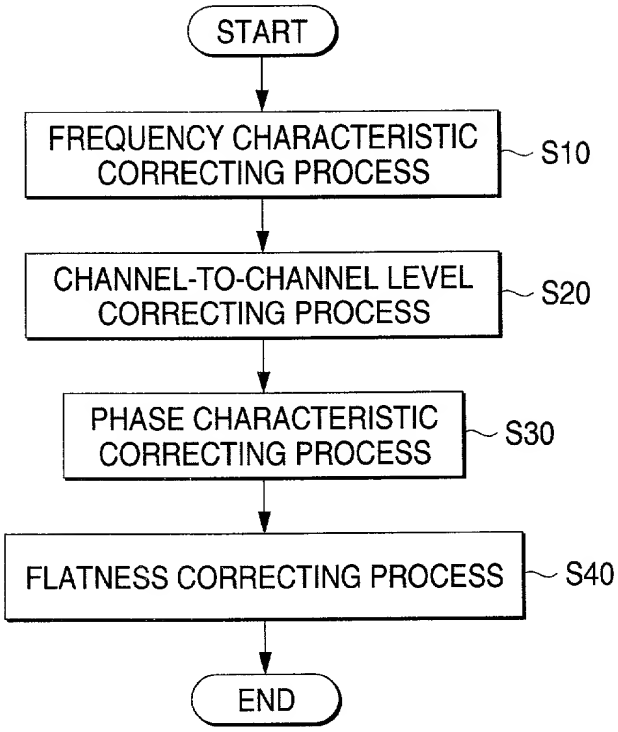
START
FREQUENCY CHARACTERISTIC CORRECTING PROCESS
S10
CHANNEL-TO-CHANNEL LEVEL CORRECTING PROCESS
S20
PHASE CHARACTERISTIC CORRECTING PROCESS
S30
FLATNESS CORRECTING PROCESS
S40
END

FIG. 9

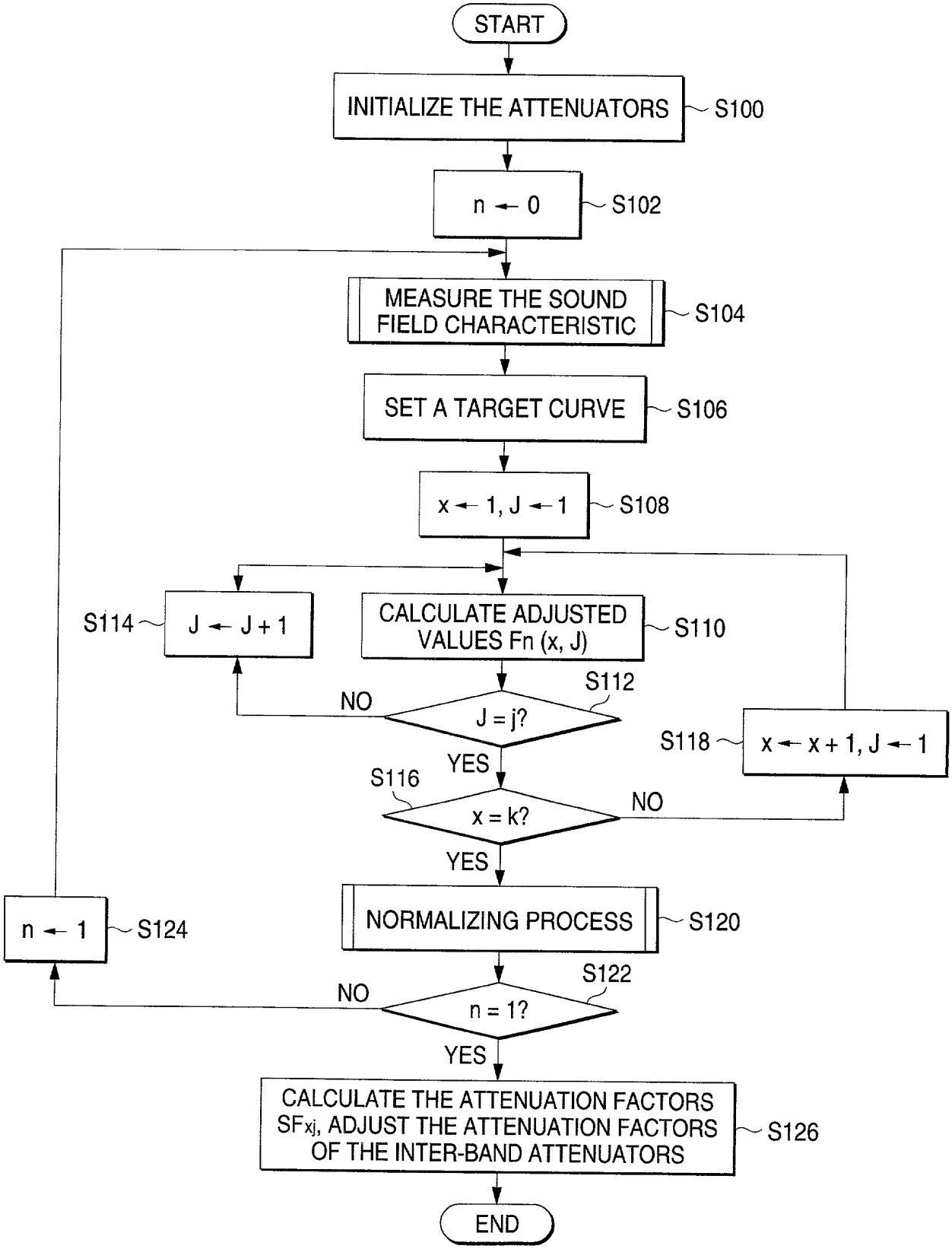
START
INITIALIZE THE ATTENUATORS
S100
n ← 0
S102
MEASURE THE SOUND FIELD CHARACTERISTIC
S104
SET A TARGET CURVE
S106
x ← 1, J ← 1
S108
CALCULATE ADJUSTED VALUES Fn (x, J)
S110
S112
J = j?
NO
S114
J ← J + 1
YES
S116
x = k?
NO
S118
x ← x + 1, J ← 1
YES
NORMALIZING PROCESS
S120
S122
n = 1?
NO
n ← 1
S124
YES
CALCULATE THE ATTENUATION FACTORS SFxj, ADJUST THE ATTENUATION FACTORS OF THE INTER-BAND ATTENUATORS
S126
END

FIG. 10

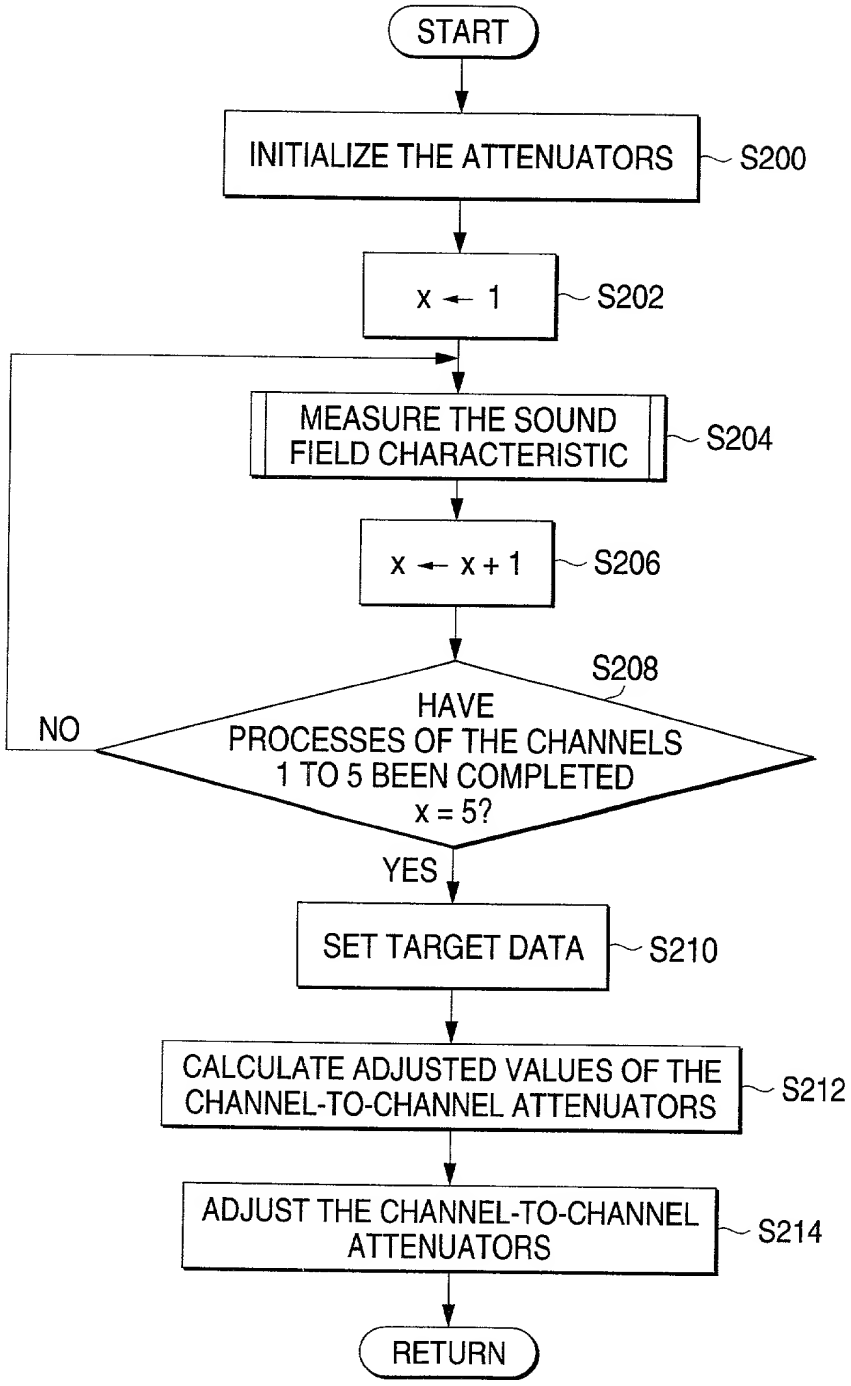
START
INITIALIZE THE ATTENUATORS
S200
x ← 1
S202
MEASURE THE SOUND FIELD CHARACTERISTIC
S204
x ← x + 1
S206
S208
HAVE PROCESSES OF THE CHANNELS 1 TO 5 BEEN COMPLETED x = 5?
NO
YES
SET TARGET DATA
S210
CALCULATE ADJUSTED VALUES OF THE CHANNEL-TO-CHANNEL ATTENUATORS
S212
ADJUST THE CHANNEL-TO-CHANNEL ATTENUATORS
S214
RETURN

FIG. 11

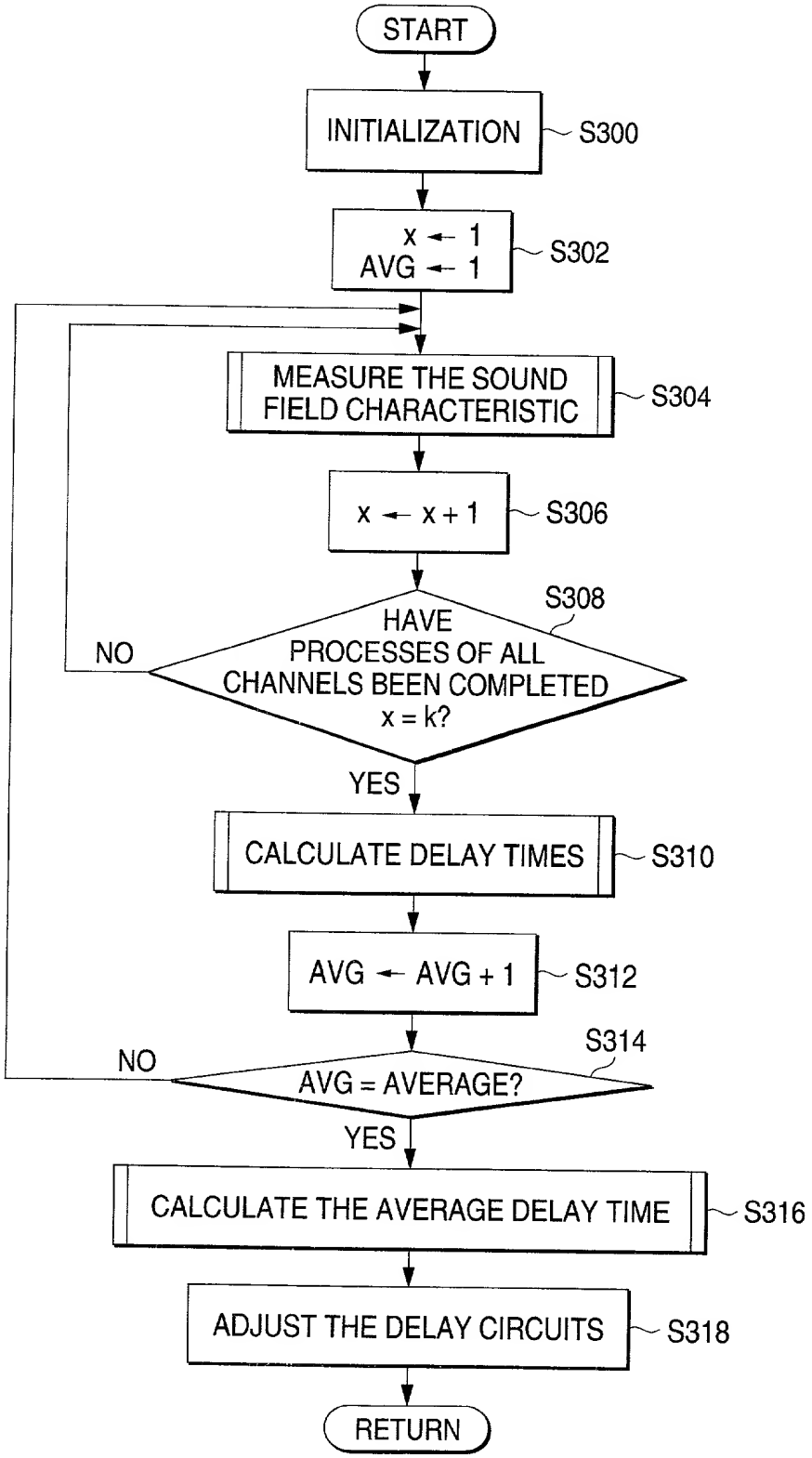
START
INITIALIZATION
S300
x ← 1
AVG ← 1
S302
MEASURE THE SOUND FIELD CHARACTERISTIC
S304
x ← x + 1
S306
S308
HAVE PROCESSES OF ALL CHANNELS BEEN COMPLETED x = k?
NO
YES
CALCULATE DELAY TIMES
S310
AVG ← AVG + 1
S312
S314
AVG = AVERAGE?
NO
YES
CALCULATE THE AVERAGE DELAY TIME
S316
ADJUST THE DELAY CIRCUITS
S318
RETURN

FIG. 12

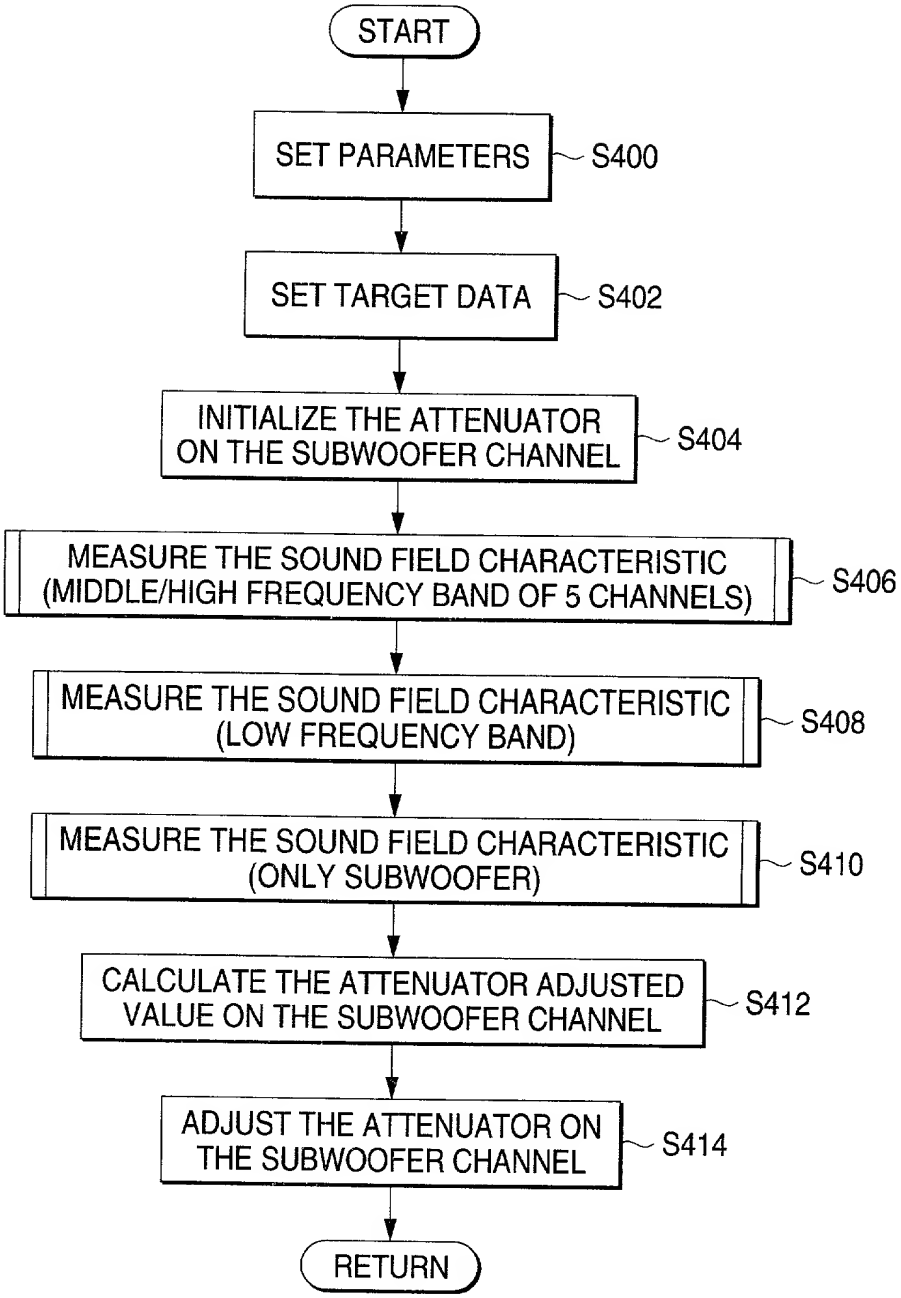
START
SET PARAMETERS
S400
SET TARGET DATA
S402
INITIALIZE THE ATTENUATOR ON THE SUBWOOFER CHANNEL
S404
MEASURE THE SOUND FIELD CHARACTERISTIC (MIDDLE/HIGH FREQUENCY BAND OF 5 CHANNELS)
S406
MEASURE THE SOUND FIELD CHARACTERISTIC (LOW FREQUENCY BAND)
S408
MEASURE THE SOUND FIELD CHARACTERISTIC (ONLY SUBWOOFER)
S410
CALCULATE THE ATTENUATOR ADJUSTED VALUE ON THE SUBWOOFER CHANNEL
S412
ADJUST THE ATTENUATOR ON THE SUBWOOFER CHANNEL
S414
RETURN

FIG.1:

(1) sound source 1

(2) signal processing circuit 2

(3) noise generator 3

(4) D/A converter 4_{FL}, 4_{FR}, 4_{C}, 4_{RL}, 4_{RR}, 4_{WF}, 10

(5) amplifier 5_{FL}, 5_{FR}, 5_{C}, 5_{RL}, 5_{RR}, 5_{WF}, 9

(6) A/D converter 10

FIG.2:

(1) noise generator 3

(2) attenuator ATF_{11}, ATF_{12} to ATF_{1j}, ATF_{k1}, ATF_{k2}, ATF_{ki}, ATG_{1}, ATG_{2}, ATG_{3}, ATG_{4}, ATG_{5}, ATG_{k}

(3) delay circuit DLY_{1}, DLY_{2}, DLY_{3}, DLY_{4}, DLY_{5}, DLY_{k}

FIG.3:

(1) frequency characteristic correcting portion 11

(2) channel-to-channel level correcting portion 12

(3) phase characteristic correcting portion 13

(4) flatness correcting portion 14

(5) system controller MPU

FIG.4:

(1) middle/high frequency band processing portion (except subwoofer) 15a

(2) low frequency band processing portion (except subwoofer) 15b

(3) subwoofer low frequency band processing portion (only subwoofer) 15c

(4) calculating portion 15d

FIG.5:

(1) logarithmic frequency (kHz)

(2) gain (dB)

(3) low frequency band

(4) middle/high frequency band

FIG.6:

(1) logarithmic frequency (kHz)

(2) power (dB)

(3) low frequency band

(4) total power of loudspeakers 6_{FL} to 6_{WF}

(5) power of loudspeakers 6_{FL} to 6_{RR}

(6) power of a loudspeaker 6_{WF}

FIG.7:

(1) front left-side loudspeaker 6_{FL}

(2) center loudspeaker 6_{C}

(3) front right-side loudspeaker 6_{FR}

(4) rear left-side loudspeaker 6_{RL}

(5) subwoofer 6_{WF}

(6) rear right-side loudspeaker 6_{RR}

FIG.8:

(1) start

(2) frequency characteristic correcting process (S10)

(3) channel-to-channel level correcting process (S20)

(4) phase characteristic correcting process (S30)

(5) flatness correcting process (S40)

(6) end

FIG.9:

(1) start

(2) initialize the attenuators (S100)

(3) measure the sound field characteristic (S104)

(4) set a target curve (S106)

(5) calculate adjusted values Fn(x, J) (S110)

(6) normalizing process (S120)

(7) calculate the attenuation factors SFxj, adjust the attenuation factors of the inter-band attenuators (S126)

(8) end

FIG.10

(1) start

(2) initialize the attenuators (S200)

(3) measure the sound field characteristic (S204)

(4) Have processes of the channels 1 to 5 been completed x=5 ? (S208)

(5) set target data (S210)

(6) calculate adjusted values of the channel-to- channel attenuators (S212)

(7) adjust the channel-to-channel attenuators (S214)

(8) return

FIG.11:

(1) start

(2) initialization (S300)

(3) measure the sound field characteristic (S304)

(4) Have processes of all channels been completed x=k ? (S308)

(5) calculate delay times (S310)

(6) calculate the average delay time (S316)

(7) adjust the delay circuits (S318)

(8) return

FIG.12:

(1) start

(2) set parameters (S400)

(3) set target data (S402)

(4) initialize the attenuator on the subwoofer channel (S404)

(5) measure the sound field characteristic (middle/high frequency band of 5 channels) (S406)

(6) measure the sound field characteristic (low frequency band) (S408)

(7) measure the sound field characteristic (only subwoofer) (S410)

(8) calculate the attenuator adjusted value on the subwoofer channel (S412)

(9) adjust the attenuator on the subwoofer channel (S414)

(10) return